



**BOISE STATE UNIVERSITY**

**ID-SBOE HERC IGEM22-002**

**Boise State University Food & Dairy Innovation Center**



**Year 1 Annual Report: July 1, 2021 – June 30, 2022**

**Contributors:**

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***Prepared for IGEM HERC by Owen McDougal***

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## 1.0 Project Overview

### A. Project Information

Funding Agency:

- Idaho Global Entrepreneurial Mission Higher Education Research Council

Awarded Institution: Boise State University

Grant Number: IGEM 22-002

Project Title: Boise State University Food and Dairy Innovation Center

Principal Investigator: Owen McDougal, Ph.D., Professor and Chair

Co-Principal Investigators:

- Assistant Professor Lisa Warner,
- Distinguished Professor Julie Oxford,
- Professor and Assoc. Dean, College of Engineering, Jim Browning,
- Professor and Dean of the College of Engineering, JoAnn Lighty

Report Type: 1<sup>st</sup> year annual progress report: July 1, 2021 – June 30, 2022

### B. Executive Summary

The \$684,000 IGEM HERC grant funds available in FY22 have been spent on personnel (\$136,100), infrastructure (\$250,000), capital equipment (\$259,200), and operating expenses/travel/recharge center fees (\$38,800). The objectives of the Food and Dairy Innovation Center (FDIC) are to create critical infrastructure and generate sponsorship for sustainable industry prioritized research. In FY23, we will begin construction of FDIC laboratories, purchase additional equipment to bolster research capabilities, secure extramural funding with academic and industry partners to expand operations, and recruit and retain student and full-time employees to staff the FDIC.

## **2.0 Introduction**

IGEM HERC funds have been used to initiate the establishment of a Food and Dairy Innovation Center (FDIC) at Boise State University. The FDIC will serve as a research core facility for regional academic institutions and industry. We seek to catalyze the modernization of Idaho's food and dairy processing industries by creating innovative technologies, providing food safety and food security training, and educating the next generation of workers to be prepared to lead in a high-tech, artificial intelligence (AI) dominated work environment. The FDIC will be a public-private lightning rod to spark economic development for all of Idaho. The FDIC is complemented by innovative transdisciplinary programs at Boise State University, and will aim to strengthen collaboration with the University of Idaho and Idaho State University, with the goal of becoming a nationally-recognized resource for research and development, for student scholarship and internship programs (e.g. VIP), and for driving economic expansion for Idaho industry. The objectives of the FDIC are to advance and create new processing technologies, establish a robust employee pipeline from university to private sector, and generate know-how and implementation of modern technology aimed at reducing usage of critical natural resources.

Year 1 – review of FY22 task list:

- 1) Construct Module 1
- 2) Hire technicians or postdocs
- 3) Recruit students (Ph.D., M.S., Undergraduate)
- 4) Purchase instrumentation
- 5) Fundraise for Module II

### 3.0 Year 1 - Summary

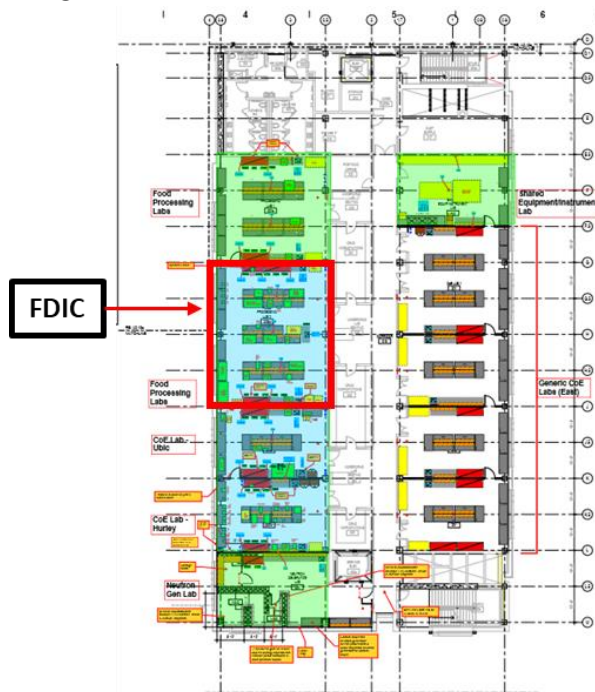
**Table 1** provides a correlation between proposed metrics and achievement from the first year of IGEM HERC funding from 7-1-2021 thru 6-30-2022.

**Table 1.** FY22 metric accomplishments

Year 1 Metric Proposed	Metric Accomplishment	Comment
Construct FDIC Module I	Modules I-III designed, budget estimate, out to bid	Funds are available to construct Modules I & II
External Funding \$500k	\$668,541	5 new grants since 7-1-21
FDIC Students Trained 3-5	31	Includes research and VIP
Patents-Publications 2-4	6 publications	2 food, 1 dairy, 3 natural product, pharmacology & toxicology
Grants & Funding - 6 submissions	8 submissions	5 awards, 2 declined, 1 pending
Internships & Jobs 2-4	6 interns, 2 jobs	Positions in ID, CA, MN

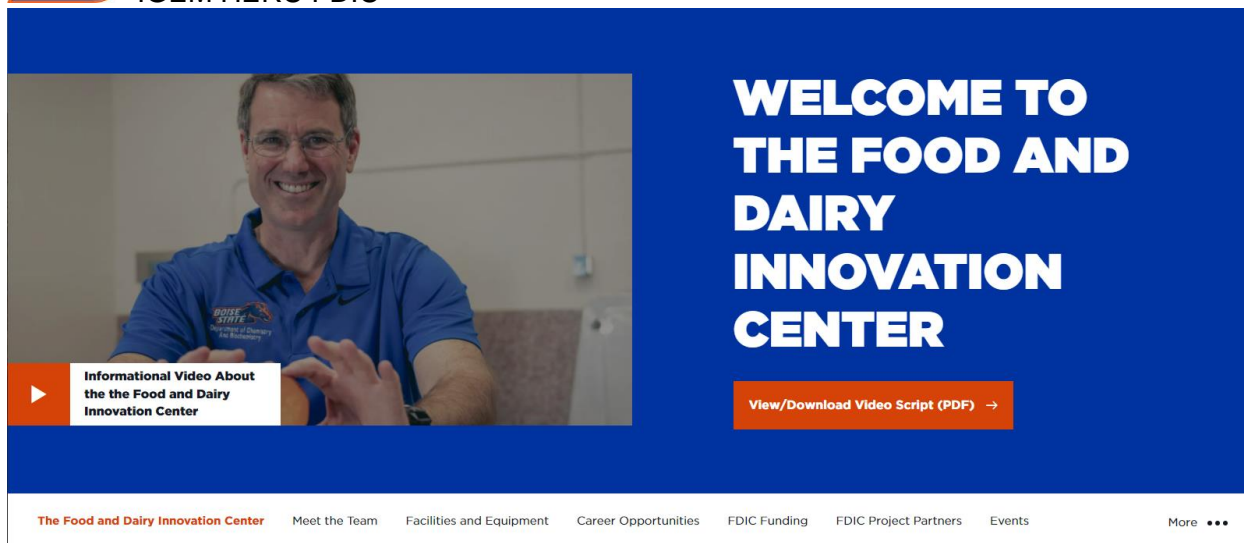
#### A. Project accomplishments for the reporting period

- 1) **Construct Module 1:** IGEM HERC funds (\$250,000) have been spent on laboratory space architectural design and planning for the third floor of the Micron Center for Materials Research (MCMR) (see **Figure 1**). IGEM HERC funds will be complemented by state of Idaho infrastructure funds dispersed to BSU that will be used to build labs on the third floor of the new building. Utilizing the IGEM HERC funds (3 yr. total = \$650,000) and state funds, two 650 sq. ft. modules will be built and the space dedicated to the FDIC. The laboratory completion date is estimated to be Fall of 2023. The IGEM HERC funds have been used to pay the State Division of Public Works (DPW) for interagency billings they send to Boise State Architectural and Engineering (A&E) Services for this project. Since the state holds the contracts, they have paid the vendors directly and then billed Boise State for what they have been authorized to spend for this construction project. At this point in time, lab design plans have been made, a budget for the project estimated, and contractors have been bid to do the construction.



**Figure 1.** MCMR level 3 floor plan with FDIC Module I&II labs boxed in red outline.

- 2) **Hire technicians or postdocs:** Several employees have been hired to work on FDIC associated projects. Co-PI Browning has used HERC funds to support engineering activity conducted by postdoctoral researcher, Dr. Marcus Pearlman, in food safety and machine learning. Toward the end of FY22, Dr. Browning added postdoctoral researcher, Dr. Ranajoy Bhattacharya, to the project. Co-PI Warner used HERC funds to support the effort of research technician Jayden Brandt, and PI McDougal used funds to support the effort of research technician Rose Saxton. PI McDougal conducted three searches for a full-time postdoctoral researcher before he gained acceptance of offer by Dr. Obyedul Azad, who will begin July 2022. Funds were also used to support the effort of Diane Smith, a grant administrator who recorded the minutes of meetings and gathered reporting data for the semi-annual IGEM HERC report. Tracy Yarnell was similarly compensated for one month of salary to establish the FDIC web site and manage news and correspondence surrounding center activity (**Figure 2**).



**Figure 2.** Homepage for the FDIC website (<https://www.boisestate.edu/fdiccenter/>).

- 3) **Recruit students (Ph.D., M.S., Undergraduate):** The FDIC has generated considerable interest from students at Boise State University and from around the region. Two Biomolecular Science (BMOL) Ph.D. students, one Chemistry MS student, and a Computer Science Ph.D. student joined the McDougal lab in Spring 2022. BMOL Ph.D. student Madison Dirks applied for and received three years of funding from BUILD Dairy (\$138,000) to support her work on the use of the dairy protein glycomacropeptide as a food ingredient, bioactive supplement, and glycosylated protein for method development. Her work was co-sponsored by Agropur. Madison is utilizing instrumentation, equipment and supplies provided by IGEM HERC. BMOL Ph.D. student Elizabeth Ryan has drafted a white paper for submission to the National Dairy Council that may fund her work focused on the use of pulsed electric field (PEF) to improve the efficiency of dairy protein powder spray drying and subsequent solubility of the resultant powder. Her work is in collaboration with food scientists at the University of Minnesota and engineers at Food Physics Group. In a separate National Dairy Council funded project to utilize infrared spectroscopy for qualitative and quantitative analysis of dairy proteins in milk, it became apparent that machine learning and artificial intelligence solutions would be required. Collaboration between Dr. McDougal and Dr. Tim Andersen in the Computer Science (CS) department at Boise State led to the recruitment of CS Ph.D. candidate Habeeb Babatunde to code software to simultaneously identify and quantify multiple proteins in milk by infrared spectroscopy. Mr. Babatunde reported on his project at the annual BUILD Dairy conference in Provo, UT in June 2022. Dr. Brandon Nelson of Daisy Brand immediately engaged with Dr. McDougal regarding Mr. Babatunde's work and a draft proposal is progressing that will fund Mr. Babatunde's graduate education as well as that of Ms. Rianat Olabisi, a





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Chemistry M.S. student. More recently, Micron School of Materials Science and Engineering second year Ph.D. student Mark Skinner joined Dr. McDougal's lab to work on heat and mass transfer kinetic modeling in PEF treated potato, grape, and barley projects. Mr. Skinner earned his ACS certified chemistry B.S. degree from Boise State, and he conducted his undergraduate capstone research in Dr. McDougal's lab, studying acrylamide formation in fried potato products.

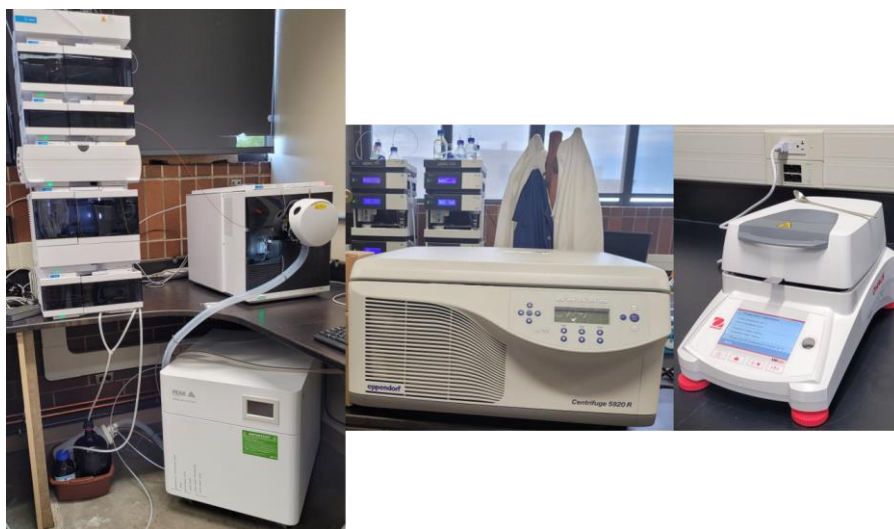
The undergraduate student recruitment into food and dairy projects is a very exciting initiative made possible due to FDIC funding. Co-PI Warner and research technician, Jayden Brandt, have designed a Vertically Integrated Project (VIP) course to be offered in fall of 2022. The VIP course is called *Food Systems*, and the audience will consist of chemistry, biology, engineering, and computer science students seeking to explore independent work into all aspects of food systems. The new postdoc, Dr. Obyedul Azad will take an active role in VIP course management, alongside McDougal and Warner. It is the goal of this year-round initiative to establish a student training pipeline leading to good career jobs in Idaho. This program will be available to students at the 200, 400 and 500 levels, to study *Food Systems*; we estimate the experience will serve a student population of around a dozen students per semester. The academic year will provide context and training to the students for food and dairy projects, and the summer will provide in-depth summer research experiences both at Boise State and through student exchange opportunities at sister institutions in Idaho and internships with industry partners. The *Food Systems* program will draw on expertise from academic and industry professionals to provide students with relevant, real world examples of emerging threats to food supply chain resilience, and provide a networking platform from which internship partnerships can be explored. In addition, Co-PI Browning, in collaboration with Biochemistry Professor Ken Cornell, have been supporting a VIP: *Plasma Medicine and Agriculture* for 7 years. This program includes biology, chemistry, and engineering students studying the use of Cold Atmospheric pressure Plasma (CAP) to kill/remove bacteria and viruses from surfaces in food processing including for dairy plants. Over this last year, 16 students participated in the course and, in addition to generating meaningful research results, they and their students presented dozens of conference posters and presentations. **Table 2** shows a summary of student participants impacted by the FDIC project team in FY22.



**Table 2.** FDIC influenced participants - FY22.

<b>FDIC Student Participation FY22</b>	
<u>Type of student</u>	<u># of Students</u>
Undergraduate Students	9
Graduate Students	6
Student Industry Internships	6
Undergraduate VIP Students	16

- 4) **Purchase instrumentation and equipment:** In FY22, capital equipment expenditures included an Agilent 1260 Infinity II liquid chromatography system equipped with a diode array detector, refractive index detector, and single quadrupole mass spectrometer (Product: SYS-LM-QUAD-E) for \$205,040, a nitrogen generator (\$24,858), an Eppendorf 5920 R Benchtop Centrifuge (\$19,104), an OHAUS MB120 moisture analyzer (\$4,812), and an Äkta Protein Chromatography System (\$10,174). **Figure 3** shows instrumentation and equipment purchased using IGEM HERC funds.



**Figure 3.** LC-DAD-RI-MS/nitrogen generator, centrifuge, and moisture analyzer (left to right).



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- Agilent 1260 Infinity II liquid chromatography system (LC-DAD-RI-MS)
  - Potato and wine sugar analysis
  - Wine organic acid analysis
  - Plant extract analysis – steroidal alkaloids and cardiac glycosides
- Nitrogen generator
  - Provides nitrogen to the LCMS system
- Eppendorf 5920 R Benchtop Centrifuge
  - Used in potato, wine and plant analysis
- OHAUS MB120 moisture analyzer
  - Malted barley moisture analysis
  - Dairy protein moisture analysis

5) **Fundraise for Module II:** PI McDougal has been working with Melanie Bannister, Senior Director of Development, College of Arts and Sciences, Boise State University to secure a \$1.1M donation for FDIC infrastructure and instrumentation. In addition, ongoing discussions have been happening between PI McDougal and Dr. Eric Bastian of Dairy West to secure a gift of a dairy protein spray dryer, and John Barber of Clextral North America for the acquisition of a twin-screw extruder.

### B. Plans for FY23

**Table 3** shows the FY23 metrics proposed in the 2021 IGEM HERC submission.

**Table 3.** Proposed metrics for FY23

<b>Year 2 Metric Proposed</b>	<b>Metric Progress</b>	<b>Comment</b>
Construct FDIC Module II	On track	Construction of modules will begin FY23 for completion fall 2023
External Funding \$1M	Grants and gifts	Progress is being made
FDIC Students Trained 5-10	Gaining momentum	Est. 25 students fall 2022
Patents-Publications 3-5	2 papers in review	On track
Grants & Funding - 10 submissions	10 submissions planned	Expect the grant submission number to increase
Internships & Jobs 5-10	On track	Industry alignment and engagement is on the rise



- 1) **Collaboration:** PI McDougal plans to: (1) work with Agropur on a BUILD Dairy sponsored project focused on glycomacropeptide; (2) work with Daisy Brand to draft a BUILD Dairy grant targeting the use of artificial intelligence to interpret infrared spectra of milk for qualitative and quantitative determination of dairy proteins; (3) initiate a new project with Glanbia to study vitamin degradation kinetics in food products; (4) submit a National Dairy Council proposal to explore the use of PEF in dairy protein powder production; (5) continue discussions with Clextral to obtain a twin-screw extruder at Boise State University; (6) submit an NSF Convergence Accelerator grant with collaborators at BSU, UI, USU, and UMN aimed at dairy protein powders; and (7) make progress on current projects focused on wine, barley, potatoes, and dairy products.
  
- 2) **Personnel and equipment investment:** In FY23, Dr. OB Azad will begin as a new postdoctoral researcher with effort dedicated to enhancing academic and industry partner access to the FDIC. Dr. Azad will provide training and mentorship of students, and lead Food Systems VIP course activities. BMOL Ph.D. student, Elizabeth Ryan will be funded on this IGEM HERC grant until her National Dairy Council grant is awarded. The grant application process opens July 2022. Equipment purchases for FY23 will include a Dumas method nitrogen analyzer, UV-Vis spectrophotometer, water bath, titrator, refractometer, and heating blocks for Soxhlet extraction: est. **\$95,000**.
  - Velp nitrogen analyzer- \$39,987
    - Nitrogen/protein analysis of food products including barley and dairy
  - Agilent Cary 60 UV-Vis spectrophotometer- \$34,729
    - Analysis of wine, barley and dairy products
  - Thermo Scientific™ Precision™ Shaking Water Bath- \$3,740
    - Barley analysis, potato blanching, microbiology, etc.
  - Multiparameter Benchtop Titrator- \$14,895
    - Barley and wine sulfur dioxide, titratable acidity, volatile acidity, reducing sugar content and Free Amino Nitrogen (FAN) analysis
  - Laxco™ Handheld Digital Brix/RI Refractometer- \$2,424
    - Sugar analysis for barley and wine
  - Heidolph™ Heat-On Blocks (250mL)- \$2,914
    - Soxhlet extraction temperature control



**3) Extramural funding planned submissions for FY23**

- A. NSF Engines Concept Paper and potential Type I proposal  
Investigators: Browning, Cornell, Bhattacharya  
Agency: USDA Food Safety
- B. Title: RF Wave Detection of Food Pathogens in Food Processing Facilities Using Machine Learning  
Investigators: Browning, Cornell, Bhattacharya  
Agency: USDA Food Safety; Amount: \$600k
- C. Title: Cold Plasma Treatment of Agricultural Seeds to Remove Contamination  
Investigators: Cornell, Browning, Plumlee  
Agency: USDA Food Improvement; Amount: \$600k
- D. Title: Building Sustainable Systems in Food Manufacturing  
Investigators: Browning, Cornell, Serra, Plumlee, Loo, Bhattacharya  
Agency: NSF; Amount: \$500k
- E. Title: Sustainable Food Processing  
Investigators: Browning, Cornell, Serra, Plumlee, Deng, Saticie, Lu (Idaho), Dillman (Lubrication Sciences International)  
Agency: USDA SAS Program; Amount: \$10M
- F. Title: NSF Convergence Accelerator Track J: Dairy Protein Product Research and Innovation Hub  
Investigators: McDougal, Andersen (BSU), Unlu (UI), Sharma (USU), Mallikarjunan (UMN), Hamlett (UI)  
Agency: NSF; Amount: \$750k
- G. Title: Assessing the Influence of Protein Glycosylation on Product Development  
Investigators: McDougal, Dirks (BSU), Rao (Agropur)  
Agency: BUILD Dairy; Amount \$138k
- H. Title: Vitamin Degradation Kinetics Across Dairy Products  
Investigators: McDougal, van Oudtshoorn (BSU), Ward (Glanbia)  
Agency: BUILD Dairy; Amount \$138k
- I. Title: Chemometric Analysis of Dairy Proteins from Infrared Spectra



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Investigators: McDougal, Andersen (BSU), Babatunde (BSU), Olabisi (BSU), Nelson (Daisy Brand)

Agency: BUILD Dairy; Amount \$200k

- J. Title: Improvement to Dairy Protein Properties Using Pulsed Electric Field Application

Investigators: McDougal, Gratzek (Food Physics/UGA), and Mallikarjunan (UMN)

Agency: National Dairy Council; Amount \$225k

### 4.0 Summary of Budget Expenditures

Table 4 shows the IGEM HERC budget expenditures from July 1, 2021 – June 29, 2022.

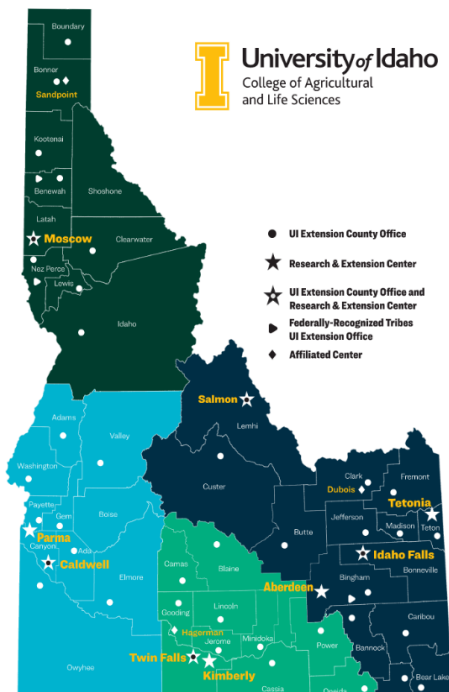
Table 4. Budget summary of funds spent from IGEM HERC to support the FDIC in FY22.

	Year 1					
	Budget Summary					
	Updated 6/29/2022					
	Year 1 Budget	Revised Budget	Total Expenses	Balance	Available Balance	Burn Rate
Salary	119,006.00	99,253.16	(99,253.16)	0.00	0.00	100%
Fringe	44,833.00	36,799.08	(36,799.08)	0.00	0.00	100%
OE	45,101.00	38,096.16	(38,096.09)	0.07	0.07	100%
Travel	9,900.00	675.52	\$ (675.52)	0.00	0.00	100%
Capital	455,040.00	509,176.08	(509,176.08)	0.00	0.00	100%
Student	10,120.00	0.00		0.00	0.00	100%
Sub Total	684,000.00	684,000.00	(683,999.93)	0.07	0.07	100%
Total Costs	684,000.00	684,000.00	(683,999.93)	0.07	0.07	100%

## 5.0 Collaborations

**Summary Statement:** PI McDougal has initiated research projects involving University of Idaho faculty and staff at the Caldwell Food Technology Center, Parma Research and Extension Center, and is working on proposals with faculty at the main campus in Moscow and extension site in Twin Falls. Industry centered projects span collaboration across the wine industry (Cinder, Telaya, Split Rail wineries), Anheuser Busch, Food Physics Group, potato chip processors (Roots, Teton Valley, etc.), Agropur, and Daisy Brand.

### A. Leverage existing infrastructure and expertise



**Figure 4.** UI extension sites in Idaho.

FY22 outreach has focused on University of Idaho extension offices, which represent the vast majority of infrastructure (see **Figure 4**) and expertise associated with agriculture in ID. Food and dairy projects that utilize the resources made available by the FDIC in FY22 have involved the following existing facilities and professionals.

- UI Parma Research and Extension Center with Professor Mike Thornton
- UI Food Tech. Center with Director Josh Bevan
- UI Moscow with Emeritus Prof. Joe Guenther
- UI Moscow with Assoc. Prof. Gulhan Unlu
- UI Moscow with Dist. Prof. Carolyn Bohach
- UI Moscow with Prof. Sam Minnich

Efforts in FY23 will be made to expand the sphere of influence of the FDIC to Idaho State University facilities, faculty and students. Prior work by PI McDougal and Idaho State University Professor Jim Groome has been supported through the Idaho

INBRE program, and utilization of the Molecular Research Core Facility was sponsored by BUILD Dairy and Gossner Foods Co. As the FDIC gains resources and personnel, the opportunities for engagement will continue to expand. McDougal plans to meet with ISU faculty to discuss opportunities made available through the FDIC in FY23. Dr. Lighty discussed with Dean Mike Parrella, as did the INL CAES Director, the NSF Engine Type 1 proposal and, specifically, the importance of the CAFE project to the effort for the state of Idaho. The lead will likely be a non-profit (concept paper is due June 30, 2022 and Dr. Lighty will submit), and Type I is due in September. The NSF Engine Type-1 grant title is *Land, Water, and Energy Innovations for a Future Snake River Basin Regional Innovation Engine*.



## **B. Lab availability**

The FDIC is still in the early stages of development and access to instruments and personnel located in the 1,000 sq. ft. of lab space that PI McDougal manages are accessible to external users. In FY23, McDougal's lab will conduct dairy protein and plant secondary metabolite quantitative and qualitative analysis, optical spectroscopy, and analyte characterization, Warner's lab will focus on protein biochemistry, Oxford's Biomolecular Research Center will provide an environment for cell culture work, advanced mass spectrometry analysis, and confocal microscopy to image cells, Browning's lab will conduct studies involving engineering, food safety and machine learning, and Lighty will consult regarding heat and mass transfer, and kinetics of food processing. Once the FDIC labs are completed in fall 2023, essential instrumentation will be consolidated into the Center to facilitate external user access through a recharge center infrastructure.

The sustainability plan for FDIC instrumentation and personnel includes the establishment of a recharge center through Boise State University. The FDIC recharge center will operate in concert with other core facilities at Boise State University to provide easy access to internal and external customers at a reasonable cost. Internal customers include members of Boise State University and faculty co-investigators from other institutions, while external customers are those at academic or industry settings outside of Boise State University. The vision for lab availability is to rely on research faculty, postdocs/research technicians and graduate students to facilitate sample preparation and data acquisition for customers. The FDIC recharge center will be modeled after the successful Biomolecular Research Center (BRC) for which project team member, Distinguished Professor Julie Oxford, serves as the BRC Director. Co-PI Oxford has generously provided guidance to PI McDougal to ensure the foundation is well established to secure FDIC sustainability and availability to all.



## 6.0 Demonstration of Economic Development/Impact

### A. Patents, copyrights, plant variety certificates

Not available

### B. Technology licenses signed, start-up businesses created, and industry involvement

- Food Physics Group (FPG) in Boise, ID, has been involved in personnel training associated with pulsed electric field (PEF) system treatment of potatoes, collaboration for the pursuit of external funding through IGEM Commerce, and access to their applications laboratory. FPG is a collaborator on three funded projects with PI McDougal.
- Anheuser Busch in Idaho Falls, ID, has partnered for a successful IGEM Commerce grant and subsequent supplemental grant associated with PEF treatment of barley to accelerate germination, and reduce water and energy demand.
- Glanbia Nutritionals in Twin Falls, ID, has provided facility tours and research priority projects that they will sponsor. It is expected that Glanbia will sponsor a project for 1-2 students in FY23.
- Agropur USA in Jerome, ID, has discussed research priority projects that they will sponsor, student internship opportunities, and hiring of former students (Tyson Hardy). Agropur has sponsored a project for BMOL Ph.D. student Madison Dirks, and provided a summer internship for BMOL Ph.D. student Joseph Collins.
- High Desert Milk and Hyacinth Proteins in Burley, ID have sponsored therapeutic drug development from agricultural sources, which has supported student research experiences (Joseph Collins).
- Lactalis American Group of Nampa, ID, has provided student internship opportunities associated with cheese quality assurance evaluation (Siomara Escobar).
- Cinder Wines of Garden City, ID, has partnered for a collaborative research project to explore the use of PEF to make better wine.
- Telaya Wine Co. of Garden City, ID, has partnered for a collaborative research project to explore the use of PEF to make better wine.
- Split Rail Winery of Garden City, ID, has partnered for a collaborative research project to explore the use of PEF to make better wine.
- DuBois Chemical of Nampa, ID, has provided student internship opportunities associated with specialty chemical formulation quality control (Delaney Odell and Robel Clifton).



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- 1,4-Group Inc. of Meridian, ID, has provided student internship opportunities associated with potato sprout inhibitor quality control (Alex Whittington).
- J. R. Simplot Co. of Boise, ID, has provided employment for a former student (Kyle Meyer).
- Daisy Brand of Dallas, TX, seeks to sponsor student research to use AI in dairy protein chemometric analysis using infrared spectroscopy in FY23.
- Lubrication Sciences International of Boise, ID makes coatings that are being studied as a method to inhibit pathogen adhesion in food processing.

### **C. Private sector engagement**

The private sector was very engaged with the FDIC in FY22 and FY23 looks to be even better. At the June 2022 BUILD Dairy annual meeting in Provo, UT, PI McDougal was able to connect with representatives from Agropur, Glanbia, and Daisy Brand that each expressed interest to sponsor new projects through BUILD Dairy, the National Dairy Council, or internal funding mechanisms. These same companies and several others (Food Physics Group, Clextral North America, and maybe even Chobani) have expressed interest to serve as collaborators for a National Science Foundation Convergence Accelerator grant together with academic partners from BSU, UI, USU, and UMN.

### **D. Jobs created**

In FY22, two students obtained full time employment at J.R. Simplot Co. (Kyle Meyer) and Agropur USA (Tyson Hardy). Another five students have earned internship opportunities through Lactalis American Group (Siomara Escobar), DuBois Chemical (Delaney Odell and Robel Clifton), 1,4-Group (Alex Whittington), Agropur (Joseph Collins), and Glanbia (Rebecca Miller).

## E. External funding – Food and Dairy

**Table 5** shows the grant activity for McDougal, Browning and Warner associated with food and dairy research projects.

**Table 5.** External funding activity associated with the FDIC.

NAME (List/PI #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL \$ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
McDougal - PI	Idaho Department of Commerce: Active: Sponsor Award Number: 004504	\$48,000	1/15/2022 – 8/30/2023	0 FTE	Economic benefit of PEF treated barley for breweries
McDougal - PI	Dairy Management, Inc. Active: Sponsor Award Number: 9133	\$151,685	6/5/2020 - 8/6/2023	8% (0.08FTE)	Cost Effective Dairy Protein Certification Method
McDougal – PI	Idaho Department of Commerce: Active: Sponsor Award Number: 004504	\$291,770	3/31/2021 – 6/15/2023	8% (0.08FTE)	PEF Potato Processing Advantage
McDougal - PI	Idaho State Board of Education: Active: IGEM22-002	\$2,098,774	7/1/2021 – 7/1/2024	15% (0.15FTE)	Boise State University Food and Dairy Innovation Center
McDougal – PI	Western Dairy Center, BUILD Dairy: Active	\$137,400	2/1/2021 – 5/15/2023	0 FTE	Spectroscopic Investigation of Bioactive Protein Constituents in Whey
McDougal – PI	Idaho State Department of Agriculture: Awarded	\$125,000	1/15/2022 – 9/30/2023	8% (0.08FTE)	Impact of smoke on potato growth, storage and profitability
McDougal – PI	Idaho State Department of Agriculture: Awarded	\$164,784	1/15/2022 – 8/15/2023	8% (0.08FTE)	Improving Grape Extraction with PEF to Make Wine Better
McDougal - PI	Idaho State Department of Commerce: Awarded	\$192,757	1/15/2022 – 12/31/2022	8% (0.08FTE)	Economic benefit of PEF treated barley for breweries
McDougal - PI	Western Dairy Center, BUILD Dairy: Awarded	\$138,000	7/1/2022 – 6/30/2024	0 FTE	Assessing the Influence of Protein Glycosylation on Product Development
McDougal – Co- PI	National Institute of Food and Agriculture/USDA: Declined	\$57,489	5/15/2022 – 1/15/2023	4% (0.04FTE)	mRNA vaccine technology adapted for delivery of novel gene/protein to strawberries
Browning – PI	NSF Future Manufacturing: Declined	\$500,000	1/15/23- 1/14/25	4% (0.04 FTE)	Building Sustainable Systems in Food Manufacturing
Warner - PI	NSF Major Research Instrumentation (MRI): Pending	\$886,232	8/1/22 – 2/28/24	0 FTE	Acquisition of a 600 MHz NMR Console and Cryoprobe to Support Research and Education at Boise State University: Pending

## F. Other pertinent information

Boise State University has just hired biophysical chemist, Dr. Konrad Meister, who studies ice nucleation and proteins that inhibit ice formation. Meister has worked on such things as the fundamental understanding of freezer burn in ice cream. Dr. Meister has accepted



IGEM HERC FDIC

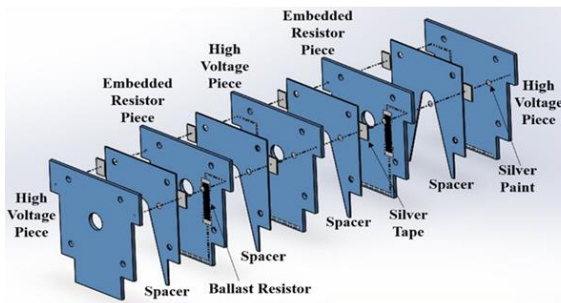
the tenure-track assistant professor position at Boise State University and BUILD Dairy has contributed to his startup package.

Co-PI Lighty has been asked to join a task force working group initiated by American Society of Agricultural and Biological Engineers (ASABE) President Paul Heinemann and led by Jim Jones. The task force is to recommend mechanisms to create alliances that connect and bring together ASABE with other professional societies and public-private sectors with expertise and tools to address complex and diverse issues associated with the Transforming Food and Agriculture in Circular Systems (TFACS) initiative. This is a result of one of the recommendations from an earlier envisioning session, which Lighty participated in, where alliances that connect and bring together ASABE with leaders of other professional societies and public-private sectors was addressed as an important step to contribute disciplinary expertise to address complex issues associated with TFACS.

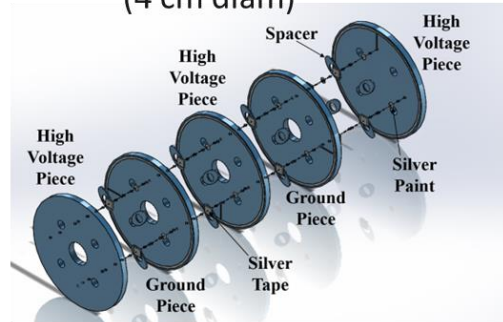
Browning has achieved research results in two areas: 1. Cold Atmospheric pressure Plasma (CAP) and 2. Radio-frequency (RF) wave detection of bacterial biofilms.

1. Our CAP system, shown in **Figure 5**, utilizes argon or air to create ionized gas (plasma) to kill or remove bacterial biofilms from surfaces. In the figure, the first image shows a planar array for treatment of surfaces and the second image shows a radial array for treating surfaces inside pipes such as in a dairy processing facility. **Figure 6** shows example results of a single etch element removing bacterial biofilms (*pseudomonas fluorescens*) from a stainless steel surface. The hazy material on the metal coupon is biofilm and a clearly visible channel has been etched into the biofilm as seen in the images for 1 min and 5 min of CAP operation. Other results have demonstrated killing of such bacteria on a variety of surfaces including glass, steel, and plastic.
2. We have been developing a new method to detect bacterial biofilms in metal pipes and pasteurizers as are found in dairy processing plants. This method involves launching RF waves into pipes and structures in the 1-5 GHz frequency range to measure the attenuation and impedance of the RF wave in the pipe or the resonant frequency of the cavity formed by the pasteurizer. These techniques should allow us to detect the formation and buildup of bacteria. Our team has simulated such a concept using the CST Studio software where we have clearly demonstrated via simulation that the impedance and resonant frequency will in fact change with bacterial build-up.

Plasma Planar Array  
(2.4 cm x 2 cm)

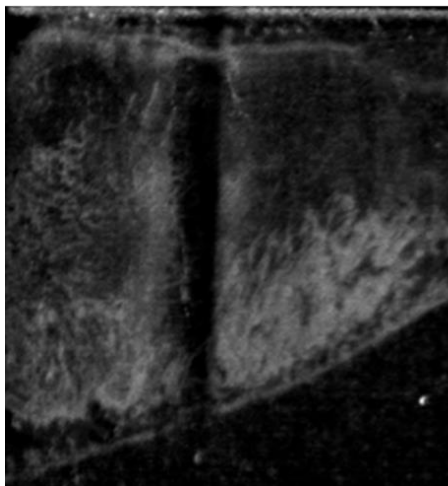


Plasma Radial Array  
(4 cm diam)

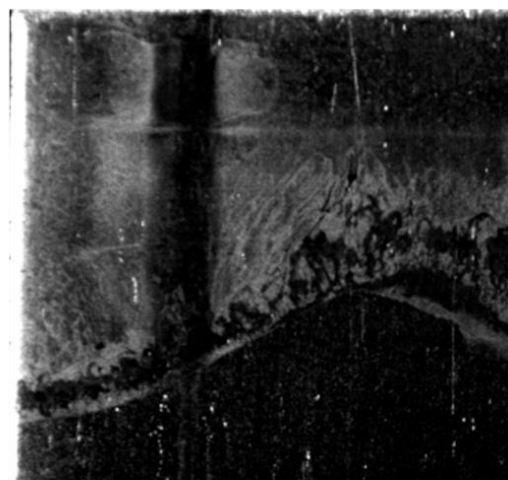


**Figure 5.** Pictorial drawings and images of our (left) planar CAP array and (right) radial CAP array for killing and removing pathogens from surfaces in food processing.

Etch time of 1 minute



Etch time of 5 minute



**Figure 6.** Images showing etched channels in a biofilm on stainless steel for (left) 1 min and (right) 5 min of CAP exposure.

## 7.0 Faculty and Student Participants as a Result of Funding

**Table 6** shows the faculty, staff and students that are involved in research that benefits from the facilities available in the FDIC.

**Table 6.** FDIC participant listing.

Person	Title/Position	Project/Topic
Owen McDougal	PI - Prof. Chemistry	FDIC / food and dairy research
Lisa Warner	Co-PI – Assist. Prof. Chemistry	Protein biochemistry & structural biology
Julie Oxford	Co-PI – Dist. Prof. Biology	Matrix Biology; protein biochemistry
Jim Browning	Co-PI – Prof. Comp. Elect. Engineering	Food safety / food security
JoAnn Lighty	Co-PI – Prof. Mech. Biomed. Engineering	Chemical engineering – kinetics
Priscila Santiago	Postdoc – Food Engineering	PEF treatment of food & beverage
Marcus Pearlman	PostDoc – Food Engineering	Plasma Treatment of bacteria
Joseph Collins	BMOL Ph.D. student	Dairy proteins / BUILD Dairy
Ranajoy Bhattacharya	Postdoc – Food Engineering	Microwave Detection of bacteria
Jared Seale	CHEM MS student	Food toxicity / poisonous plants
Sam Robinette	CHEM BS student	Potato chip acrylamide reduction
Madison Dirks	BMOL Ph.D. student	Dairy protein bioactivity / BUILD Dairy
Elizabeth Ryan	BMOL Ph.D. student	PEF treatment of food & beverage
Rose Saxton	Research Technician	Dairy protein & PEF wine
Mark Skinner	MSMSE Ph.D. student	PEF heat/mass transfer kinetics
Jayden Brandt	Research Technician	Food System VIP course coordination
Hayley Shuagis	CHEM BS student	Food toxicity / poisonous plants
Mady Tyndall	CHEM BS student	Dietary supplement safety
Olivia Brown	CHEM BS student	Food toxicity / poisonous plants
Nick Franklin	CHEM BS student	PEF treatment of food & beverage
Ajay Atkinson	CHEM BS student	Smoke potato quality assessment
Emily Garden	INBRE Summer Fellowship	Toxicology studies of Tianaa
Matt Lorentz	CHEM BS student	PEF wine studies
Kiana Mohammadi	HS student	Dairy GMP ingredient studies
Diane Smith	Grant Administrator	Meeting minutes and progress reports
Tracy Yarnell	Website Designer	Creation of FDICenter website
Eric Baggs	Postdoc – Protein Biochemistry	Protein biochemistry/Isolation
Gulhan Unlu	UI Associate Professor	Dairy microbiology
Josh Bevan	UI Director Food Technology Center	Potato processing and barley malting
Mike Thornton	UI Professor	Potato growth trials
Joe Guenther	UI Emeritus Professor	Potato economic analysis
Carolyn Bohach	UI Distinguished Professor	INBRE student fellowship support
Sam Minnich	UI Professor	INBRE network meeting coordination



## **8.0 Future Plans for Project Continuation or Expansion**

For FY23, we have hired postdoctoral researcher, Dr. OB Azad, identified additional industry partners to sponsor research activity (Agropur, Glanbia, Daisy Brand, and Clextrol) to sustain operations, we will seek external funding for collaborative projects with UI faculty Unlu and Hamlett, and will seek to recruit additional students into food and dairy research and internship programs. Outreach to ISU will be conducted in FY23 with the goal of identifying collaborative activities that draw upon the resources available in the FDIC. Until the FDIC labs are constructed in the MCMR, work will be carried out across FDIC team members' individual spaces. Goals for FY23 include tangible collaborative projects with faculty at UI and ISU, and a continued focus on addressing the needs of Idaho industry. A driver for the FDIC activities is the research experiences for students that provide essential skills for employment. The fall 2022 VIP course will be the primary mechanism to build student competency.

## **9.0 Commercialization Revenue**

Nothing to report.